An Historic Collection of Fleas (Siphonaptera) in the Macleay Museum, Sydney, Australia

R. L. C. PILGRIM
(Communicated by D. S. HORNING, JR)

PILGRIM, R. L. C. An historic collection of fleas (Siphonaptera) in the Macleay Museum, Sydney, Australia. *Proc. Linn. Soc. N.S.W.* 113 (1), 1992: 77-86.

Specimens of 58 fleas, representing 12 genera, 15 species and subspecies, together with 2 larvae, obtained by collecting, purchase or exchange, are identified and listed according to current taxonomic practice. They had been collected in Australia, Cuba, Europe, South Africa, and South America.

R. L. C. Pilgrim, Department of Zoology, University of Canterbury, Private Bag, Christchurch, New Zealand; manuscript received 5 March 1991, accepted for publication 22 May 1991.

INTRODUCTION

The Macleay Museum, University of Sydney, has an insect collection of about 500 000 specimens (Horning, 1984: 172). Many of these specimens were collected during the early to mid 1800's, and so constitute irreplaceable and historically valuable records. The collection was virtually inaccessible from 1912 to 1982 but the appointment of a curator had made the material available for re-examination. The historic flea collection, of 58 adults and 2 larvae, was sent to me for preparation and identification.

Much of the collection, as received, was in a superficially poor condition: most specimens were glued to card or paper, or to mica slips; some were entirely obscured by fungal hyphae and a great deal of accumulated dust; five adults were pinned.

Preparation involved soaking the specimens from the card/paper/mica mounts and the shellac fortunately dissolved readily. Those that were pinned had been removed prior to receipt by me: they had been relaxed for 1-1½ days in a thymol crystal/water relaxing chamber at 40°C., the lower end of the corroded pin scraped clean with forceps, and the flea then slid off the pin. The pins had been thrust through the mid-abdomen, consequently the genitalia and the diagnostically critical posterior segments were retained almost intact. Inevitably many setae were lost, as were some portions of legs and maxillae; nevertheless, surprisingly good results were obtained using a standard slide preparatory technique (Smit, 1957), such that the specimens presented few taxonomic problems attributable to the condition of the material. Some abdomens were badly broken open and occasionally spermathecae became exteriorized on the slide or lost.

The original labels were kept and glued to the microscope slide (right side); where more than one species was present on the original labelled mount, a full replicate of the data has been placed in the corresponding position on the additional slide(s).

SYSTEMATICS

The species present in the collection are listed below. Higher taxonomy of the fleas follows Smit (1982); the subfamilies and tribes of Pygiopsyllidae are those of Mardon (1981) and the subgenera of *Ceratophyllus* those of Smit (1983). Nomenclature of the hosts follows Ride (1970) for Australian, and Hall and Kelson (1959) for North American and Cuban hosts.

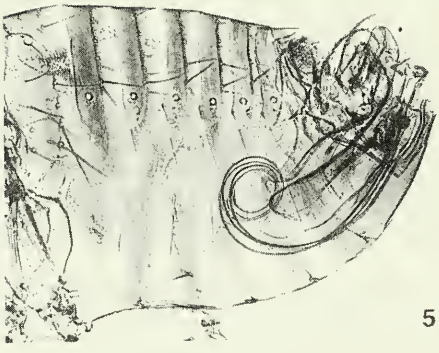
Entries are arranged as follows: number, for ease of reference; current name of flea species, with author and date; number of specimens of each sex; number of slides

1

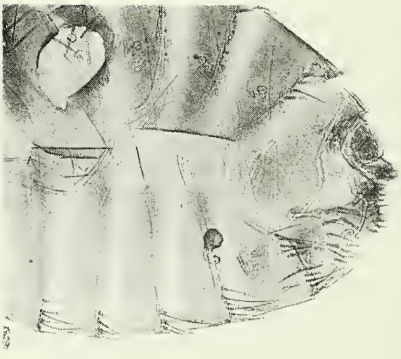
2

3

4



5



6

Fig. 1. Stephanocircus dasyuri Skuse, male (entry 2).
Fig. 2. Bradiopsylla echidnae (Denny), female (entry 3).
Fig. 3. Phthiropsylla agenoris (Rothschild), female (entry 9).
Fig. 4. Pariodontis riggenbachi riggenbachi (Rothschild), female (entry 10).
Fig. 5. Pulex simulans Baker, male, abdomen (entry 14.5).
Fig. 6. Pulex simulans Baker, female, abdomen (entry 14.7).

prepared; original state of mounting of specimens; transcript of original labels (in quotation marks).

Conditions of specimens as now slide-mounted.

Remarks on fleas and/or host(s) and/or localities.

My remarks, corrections or other comments on the original data are interpolated in square brackets [ ].

* denotes specimen(s) of Australian provenance.

** denotes specimen(s) endemic or native to Australia.

In many cases, no host was stated on the original label(s); additionally some labels lacked any locality data, but in a few instances deductions are offered as to probable sites of collection.

HYSTRICHOPSYLLOIDEA

HYSTRICHOPSYLLIDAE

Hystrichopsyllinae — Hystrichopsyllini

1. ***Hystrichopsylla (Hystrichopsylla) talpae (?talpae)*** (Curtis, 1826)
   1 female, containing egg, remounted from card. 'Mole Flea female. J. J. Walker Oxford [England] 1908' [W. W. Froggatt's handwriting]. 'From Mr Froggett [*sic*] April 17.1918' [John Shewan's handwriting].
   Condition: excellent.
   Remarks: subspecies of *talpae* are indistinguishable in the absence of males; the subspecies *t. talpae* is assumed from the locality, since only *t. talpae* is known from England (Hopkins and Rothschild, 1962: 45; Beaucournu and Launay, 1979: 499).

STEPHANOCIRCIDAE

Stephanocircinae

2. ***Stephanocircus dasyuri* Skuse, 1893. Fig. 1.
   2 males on 1 slide, remounted from same piece of mica. 'Perameles nasutus' [=*P. nasuta* Geoffroy, 1804] [W. S. Macleay's handwriting, pre-1865]. No locality stated, but host known to occur in eastern parts of Queensland, New South Wales and Victoria (Ride, 1970: 100).
   Condition: excellent; 1 abdomen burst open but genitalia retained.
   Remarks: the species is very common, and has been recorded from a wide range of macropods, peramelids, large dasyurids and native rodents in Australia (including Tasmania), mainly in coastal regions (Dunnet and Mardon, 1974: 105).

PYGIOPSYLLIDAE

Lycopsyllinae — Bradiopsyllini

3. ***Bradiopsylla echidnae* (Denny, 1843). Fig. 2.
   2 females on 2 slides, remounted from 1 card. 'Pulex echidnae Denny and larvae from Echidna hystrix' [=*Tachyglossus aculeatus* (Shaw, 1792)]. 'N.S.W.' [New South Wales].
   Condition: very good.
   Remarks: specimens known to have been obtained by W. S. Macleay between 1839 and 1860 (*teste* D. S. Horning, Jr). The two associated larvae from the same card have been prepared and mounted independently, and will be referred to in a subsequent paper by me. The genus *Bradiopsylla* is monotypic and endemic to Australia; it has been taken almost exclusively from echidnas of which *T. aculeatus* is the typical host (Dunnet and Mardon, 1974: 55).

Pygiopsyllinae

4. ***Pygiopsylla phiola* Smit, 1979.
1 male, 1 female on 1 slide, remounted from same piece of mica. 'Perameles' [W. S. Macleay's handwriting, pre-1865]. No locality stated, but Smit (1979: 172) recorded the species from a number of hosts, including *Perameles nasuta* in Queensland and New South Wales.
Condition: very good; male abdomen burst open, but genitalia retained.
Remarks: Smit (1979: 173) regarded this species as belonging to Australia, whence it has spread with *Rattus* spp. to New Zealand and its outlying islands.

CTENOPHTHALMIDAE

Ctenophthalminae — Ctenophthalmini

5. ***Palaeopsylla minor*** (Dale, 1878)
2 females on 1 slide, remounted from 1 card. 'Talpa' [?C. L. Nitzsch's handwriting]. No locality stated, but the species is very common on *Talpa europaea* Linnaeus, 1758 throughout Europe, including England (Smit, 1957: 37).
Condition: very good; 1 specimen has lost the spermatheca.
Remarks: specimens probably purchased or exchanged.

CERATOPHYLLOIDEA

CERATOPHYLLIDAE

Ceratophyllinae

6. ***Ceratophyllus (Ceratophyllus) gallinae*** (Schrank, 1803)
1 male, remounted from card. 'Pulex gallinae' [W. S. Macleay's handwriting]. No host or locality stated; the species is very host-promiscuous on birds, especially poultry, and has been accidentally introduced to most parts of the world. Australian records are not common (Dunnet and Mardon, 1974: 130).
Condition: excellent.
Remarks: specimen known to have been derived from the Latreille collection (*teste* D. S. Horning, Jr); thus not of Australian origin.

7. ***Ceratophyllus (Monopsyllus) sciurorum sciurorum*** (Schrank, 1803)
1 male, remounted from card. 'Pulex sciuri' [W. S. Macleay's handwriting]. No host or locality stated; regular hosts are sciurids and glirids throughout much of the Palaearctic Region (Haddow *et al.*, 1983: 76, maps 41, 167).
Condition: very good, but extreme tip of sternum VIII broken off.
Remarks: specimen known to have been derived from the Latreille collection (*teste* D. S. Horning, Jr).

ISCHNOPSYLLIDAE

Ischnopsyllinae

8. ***Ischnopsyllus (Hexactenopsylla) hexactenus*** (Kolenati, 1856)
2 females on 1 slide, remounted from 1 card. 'Pulex vespertilionis' [W. S. Macleay's handwriting]. No host or locality stated; occurs on bats throughout much of European sub-region of the Palaearctic Region (Hopkins and Rothschild, 1956: 305).
Condition: excellent.
Remarks: specimens known to have been derived from the Latreille collection (*teste* D. S. Horning, Jr). *Pulex vespertilionis* Bouché, 1835 is a synonym of *I. hexactenus* (Hopkins and Rothschild, 1956: 306).

MALACOPSYLLOIDEA

MALACOPSYLLIDAE

9. ***Phthiropsylla agenoris*** (Rothschild, 1904). Fig. 3.
1 female, remounted from pin. 'Flea on Dasypus minutus Bahia Blanca N. Patagonia Darwin.' [W. S. Macleay's handwriting].
Condition: very good; scarcely any damage from pinning.
Remarks: this specimen is of exceptional interest — it is listed in Smith (1987: 43, entry 376) as one of the missing specimens from 'Darwin's Insects'. The original label was attached to the slide by Ricardo Palma, National Museum of New Zealand. It is sealed between two layers of 'Mylar' ® (a polyester film used to conserve paper), glued to each other with a frame of '3M' ® No. 415 double-sided adhesive tape.

The species of this monotypic genus is typically found on armadillos in the Neotropical Region (Smit, 1987: 20).

PULICOIDEA

PULICIDAE

Xenopsyllinae

10. ***Pariodontis riggenbachi riggenbachi*** (Rothschild, 1904). Fig. 4.
1 female, remounted from pin. '2814' on green paper label. No locality stated, but specimen is known to have been collected at the Cape of Good Hope, South Africa (*teste* D. S. Horning, Jr).
Condition: very good; hole in abdomen almost closed over by manipulation of flaps of cuticle; spermatheca floated out of the opening during maceration but was coaxed back inside the abdomen before slide-mounting. One hind leg is detached.
Remarks: specimen is derived from the Verreaux collection 1825-1830 (*teste* D. S. Horning, Jr). Jules Pierre Verreaux lived at the Cape of Good Hope from 1825-1830, where he made collections of invertebrates. Subsequently the collections made in Africa and his manuscript notes were lost in the wreck of the *Lucullus* in 1838 (Musgrave, 1932: 333). But Macleay (1838: 1) wrote 'It may be well that I should mention here my having lately acquired, by purchase, the very extensive collection of *Annulosa* made by M. Verreaux during his long residence at the Cape, and also his manuscript notes on the species collected.' The specimens are readily recognized by the small numbered green labels. Unfortunately the location of the manuscript notes is unknown.

The species occurs on porcupines (*Hystrix* spp.) and is widespread through much of Africa (Hopkins and Rothschild, 1953: 234).

Archaeopsyllinae

11. ***Ctenocephalides felis felis*** (Bouché, 1835)
11.1 2 females on 2 slides, remounted from 2 pins. 'Cuba'.
Condition: good.
Remarks: these and all subsequent 'Cuba' labels in this genus are in W. S. Macleay's handwriting and all are derived from collections made during his stay in Cuba between 1826 and 1836 (Horning, 1984: 173).
11.2 1 female, remounted from card. 'Cuba".
Condition: good, but spermatheca lost during maceration.
Remarks: same card originally bore a very damaged unidentified mite, which was stained with Carbol Fuchsin and remounted on a separate slide.

11.3 2 males on 1 slide, remounted from 1 card. 'Cat. Cuba'.
Condition: excellent.
11.4 1 female, remounted from card. 'Cuba'.
Condition: good; slight fracture in frons.
11.5 2 males, 3 females on 4 slides, remounted from 4 separate cards. 'Cuba'.
Condition: excellent; 1 male failed to macerate thoroughly.
Remarks: 2 females originally on same card with 1 female *Pulex* (?*simulans*), see entry 14.6.
11.6 4 males, 1 female on 3 slides, remounted from 1 card. 'On Capromys Fournieri' [origin of handwriting unknown]. No locality stated.
Condition: excellent; 1 female has genal spines broken and spermatheca missing.
Remarks: originally on the same card with 1 male *Pulex simulans*, see entry 14.5. *Capromys fournieri* Desmarest, 1822 was synonymized with *C. p. pilorides* (Say, 1822) according to Hall and Kelson (1959: 794) in which the type locality of *C. fournieri* is Cuba. However, Walker *et al.* (1964: 1035) further circumscribed the host locality as Isla da Piños, Cuba.
11.7 1 female, remounted from card. 'Dog'. No locality stated but 'Cuba' on separate pin alongside specimen label.
Condition: fair; many genal spines, pronotal spines and body setae broken short.
Remarks: originally on same card with 4 female *Ctenocephalides canis*, see entry 12. It is not unusual for *Ct. f. felis* (cat flea) to be taken from dogs, and another instance from Cuba is reported in Hopkins and Rothschild (1953: 153).

12. ***Ctenocephalides canis*** (Curtis, 1826).
4 females on 2 slides, remounted from 1 card. 'Dog'. No locality stated, see entry 11.7.
Condition: good; some genal spines broken short.
Remarks: originally on same card with 1 female *Ctenocephalides f. felis*, see entry 11.7. *Ct. canis* (dog flea) is not reported from Cuba (Hopkins and Rothschild, 1953: 169; García Avila, 1976).

Occurrence of *Ctenocephalides* spp. in the Collection

Taxonomic separation of the two species of *Ctenocephalides* most commonly found, virtually world-wide, on domestic cats and dogs relies on a combination of characters (Holland, 1949; Hopkins and Rothschild, 1953; Smit, 1957). None of these features is alone absolutely reliable since variations may be found especially in the number of setae on the metepisterna or on the hind tibiae, even on the two sides of a specimen.

In view of the fact that no records of *Ct. canis* in Cuba appear in either Hopkins and Rothschild (1953: 169) or García Avila (1976), despite the presence of dogs as flea hosts (Hopkins and Rothschild, 1953: 153; and see entry 11.7), a very detailed inspection of the specimens was undertaken. As well as reference to standard literature, examination of each male and female was made using a Zeiss 'Comparison Eyepiece Bridge' to compare the Cuban specimens against authenticated *Ct. f felis* and *Ct. canis* material.

Of those specimens identified here as *Ct. f. felis* (entries 11.1-11.7), the eight males all possess only two metepisternal setae on each side (or their alveoli where setae are lost); head shape, and length of the first genal spine agree well with Holland's fig. 14 (1949); the hind tibiae show only one major seta between the postmedian and the apical long setae (Hopkins and Rothschild, 1953: 136, fig. 157) (= seta A in Smit, 1957: fig. 39); setation and shape of the manubrium and of the movable process of the clasper agree with Holland's fig. 16, and Smit's fig. 41: the nine females also possess only two metepisternal setae (or alveoli) on each side; head shape, and length of the first genal spine (except in three instances where the spines are broken short on one side) agree well

with Holland's fig. 15; the hind tibiae show only 1 major seta (or its alveolus) agreeing with Hopkins and Rothschild's fig. 157 and Smit's seta A.

Of those specimens identified here as *Ct. canis* (entry 12), three of the four females possess three metepisternal setae on each side, one has three on the right and two on the left side; head shape, and length of the first genal spine agree well with Holland's fig. 12; the hind tibiae all show two major setae between the postmedian and the apical long setae as in Hopkins and Rothschild's fig. 158 (= setae A and B in Smit: fig. 34).

The validity of the identifications is thus held to be as shown under entries 11 and 12. The presence of both these species of *Ctenocephalides* on the (presumed) single host dog (entries 11.7 and 12) is not remarkable; it is not unusual for both to be found together on the same host cat or dog.

Pulicinae

13. ***Pulex irritans*** Linnaeus, 1758

13.1 1 male, remounted from card. 'Pavon [*recte* Pavón = peacock] Pulgas [fleas] Spain' [origin of handwriting unknown].

Condition: excellent.

Remarks: this species (human flea) is now distributed virtually world-wide; its occurrence on peacock (*Pavo cristatus* Linnaeus, 1758) is no doubt accidental. The Spanish 'Pulgas' is plural, but only 1 specimen was present on the card mount as received by me.

*13.2 1 female, remounted from card. 'Opossum NSW' [New South Wales] [W. S. Macleay's handwriting].

Condition: excellent.

Remarks: the occurrence on 'opossum' (=*Trichosurus vulpecula* (Kerr, 1792)) is no doubt accidental; Dunnet and Mardon (1974: 34) include only one record of the species on that host.

*13.3 3 females on 3 slides, remounted from 3 cards. 'NSW' [New South Wales] [W. S. Macleay's handwriting].

Condition: excellent.

Remarks: no indication of host.

13.4 4 males on 2 slides, remounted from 1 card. 'Portugal' [very small type-set label].

Condition: excellent; some damage to legs of 1 specimen.

Remarks: no indication of host or date. Sir William John Macleay had hundreds of world-wide locality labels typeset after the 1874 *Chevert* expedition to New Guinea. In the Macleay Museum today, there are 156 small boxes, containing thousands of very small, hand cut labels, including 'Portugal'.

14. ***Pulex simulans*** Baker, 1895.

14.1 1 male, 1 female on 1 slide, remounted from 1 card. 'Cuba'.

Condition: fair; both specimens failed to macerate adequately, and some legs are broken short or missing completely; female abdomen badly damaged.

14.2 2 males on 1 slide, remounted from 1 card. 'Negro hut in Cuba'.

Condition: fair; both abdomens damaged, and legs broken short or missing completely, but genitalia quite discernible.

Remarks: obtained by W. S. Macleay between 1826 and 1836 [*teste* D. S. Horning, Jr].

14.3 2 males on 2 slides, remounted from 2 cards. 'Cuba'.

Condition: very good.

14.4 1 female, remounted from card. 'Cuba'.

Condition: fair; spermatheca exteriorized. (Species identification uncertain.)

14.5 1 male, remounted from card. 'On Capromys Fournieri.'. Fig. 5.
Condition: excellent; left hind tibia lacks 3 podomeres.
Remarks: originally on same card with 4 males and 1 female *Ctenocephalides f. felis*; see entry 11.6 for remarks on host and locality. *Capromys* spp. are not specifically mentioned as hosts of *P. simulans* by either Smit (1958) or Hopla (1980).
14.6 1 female, remounted from card. 'Cuba'.
Condition: very good.
Remarks: originally on same card with 2 female *Ctenocephalides f. felis*, see entry 11.5.
14.7 2 females on 2 slides, remounted from separate pins. 'Cuba'. Fig 6.
Condition: very good; some legs broken short, but damage to abdomens is minimal.

15. ***Pulex*** sp. indet.
1 female, remounted from card. 'Cuba'.
Condition: poor; very badly damaged (by chewing insects?) prior to receipt by me.

Pulex simulans was, for many years, synonymized with *P. irritans* by Jordan and Rothschild, 1908, following its reduction to a variety by the original describer, Baker, (1904: 379) but was re-established as a separate species by Smit (1958), who included Cuba (as cited in Hopkins and Rothschild, 1953: 115 'from rats') among the sites of natural occurrence. Hopla (1980) gave a wide range of hosts for this species in the United States, but burrowing rodents appear to be the preferred hosts; *Capromys fournieri* [= *Capromys p. pilorides*] is described as 'arboreal' (Burton, 1970: 91).

TUNGIDAE

16. ***Tunga penetrans*** (Linnaeus, 1758)
1 female (undistended), remounted from card. 'nigua' [= chigoe, sand-flea] [origin of handwriting unknown]. 'Cuba' [W. S. Macleay's handwriting].
Condition: good, but both hind legs broken off at femoro-tibial joint.
Remarks: the state of the abdomen corresponds approximately to that depicted in Hopkins and Rothschild, 1953, fig. 21A. The usual host is man, and the species is widespread in tropical parts of Neotropical and Ethiopian Regions; it was recorded from Cuba by García Avila (1976: 13).

MISCELLANEOUS

17. One label was unaccompanied by any specimen. It reads '*Pulex hirundinis*', without further data. This species, now *Ceratophyllus* (*Ceratophyllus*) *hirundinis* (Curtis, 1826), is widespread on passerine birds in the European and west Siberian subregions of the Palaearctic Region (Smit, 1983: 62, maps 24, 172).

Discussion

Few specimens in the collection were taken in Australia: two endemic species (four specimens, entries 2, 3); one species (2 specimens, entry 4) native to Australia though now found elsewhere; a few specimens of 'human flea' (entries 13.2, 13.3) introduced to the continent probably from Europe. These specimens of Australian origin are of value in the history of Australian entomology and they do not appear to have been recorded previously.

The 'Darwin Flea' (entry 9) is of great interest as it represents a hitherto presumed lost specimen (Smith, 1987); its reappearance goes some way towards completing the record of Darwin's entomological relicts.

The remainder of the material comprises: some specimens collected from Europe

(entries 1, 5-8, 10, 13.1, 13.4) no doubt obtained by W. S. Macleay by exchange, gift or purchase; the rest are from Cuba, reflecting Macleay's interests during his residency there. The flea fauna of Cuba and vicinity seems to be relatively unexplored. García Avila (1976) recorded only *Ctenocephalides felis* and *Tunga penetrans*, both of which are here confirmed. *Ct. canis*, whose usual host is dogs, may have been overlooked by García Avila or he may have failed to separate the species from *Ct. felis*. His failure to report any species of *Pulex* is surprising, as *P. irritans* at least is widespread. Most of the species referred to in this paragraph are not uncommon; their importance lies chiefly in their historical aspect in that they reveal transactions of collecting, purchasing and exchanging among the persons referred to in the text.

Acknowledgements

I wish to thank Dr D. S. Horning Jr, for the opportunity to examine the collection and for much assistance in deciphering records, including the identification of handwriting on the labels. Authenticated specimens of *Pulex simulans*, used for comparison, were kindly provided by Mrs Annette Seccombe and the Trustees of the Natural History Museum, London; by Professor Robert Traub, Smithsonian Institution, Washington, D.C.; and by Drs E. C. Greiner and C. B. Beard, University of Florida, Gainesville. I am indebted to Mr T. P. Williams, University of Canterbury, Christchurch for photographic services.

Some of the equipment used in this study was partly provided under a grant from the New Zealand Lottery Board.

References

Baker, C. F., 1904. — A revision of American Siphonaptera, or fleas, together with a complete list and bibliography of the group. *Proc. U.S. natn. Mus.* 27(1361): 365-469.

Beaucournu, J. C., and Launay, H., 1979. — Le genre *Hystrichopsylla* Taschenberg (1880) dans l'ouest du bassin méditerranéen (Siphonaptera, Hystrichopsyllidae). *Annls Soc. ent. Fr. (N.S.)* 15(3): 489-504.

Burton, M., 1970. — *Dictionary of the World's Mammals*. London: Sphere Books.

Dunnet, G. M., and Mardon, D. K., 1974. — A monograph of Australian fleas (Siphonaptera). *Aust. J. Zool. (Suppl. ser.)* 30: 1-273.

García Avila, I., 1976. — Insectos hematófagos de Cuba. *Poeyana* (154): 1-15.

Haddow, J., Taub, R., and Rothschild, M., 1983. — Distribution of ceratophyllid fleas and notes on their hosts. *In* Traub, R., Rothschild, M., and Haddow, J. F. (eds), *The Rothschild Collection of Fleas. The Ceratophyllidae: Key to the Genera and Host Relationships:* 42-163. London: Rothschild and Traub.

Hall, E. R., and Kelson, K. R., 1959. — *The Mammals of North America. Vols I-II*. New York: Ronald Press Company.

Holland, G. P., 1949. — The Siphonaptera of Canada. *Dom. Can. Dep. Agric. Tech. Bull.* 70: 1-306.

Hopkins, G. H. E., and Rothschild, M., 1953. — *An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History). Vol. I Tungidae and Pulicidae*. London: Trustees of the British Museum.

——, and ——, 1956. — *An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History). Vol. II. Coptopsyllidae, Vermipsyllidae, Stephanocircidae, Ischnopsyllidae, Hypsophthalmidae and Xiphiopsyllidae*. London: Trustees of the British Museum.

——, and ——, 1962. — *An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History). Vol. III. Hystrichopsyllidae (Acedestiinae, Anomiopsyllinae, Hystrichopsyllinae, Neopsyllinae, Rhadinopsyllinae and Stenoponiinae)*. London: Trustees of the British Museum.

Hopla, C. E., 1980. — A study of the host associations and zoogeography of *Pulex*. *In* Traub, R. and Starcke, H. (eds), *Fleas:* 185-207. Rotterdam: Balkema.

Horning, D. S., Jr., 1984. — The Macleay insect collection. *Antenna* 8(4): 172-175.

Jordan, K., and Rothschild, N. C., 1908. — Revision of the non-combed eyed Siphonaptera. *Parasitology* 1(1): 1-100.

Macleay, W. S., 1838. — *Illustrations of the Annulosa of South Africa; Being a Portion of the Objects of Natural History Chiefly Collected During an Expedition into the Interior of South Africa, Under the Direction of Dr. Andrew Smith, in the Years 1834, 1835, and 1836*. London: Smith, Elder and Co.

MARDON, D. K., 1981. — *An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History). Vol. VI. Pygiopsyllidae.* London: Trustees of the British Museum (Natural History).

MUSGRAVE, A., 1932. — *Bibliography of Australian Entomology 1775-1930 with Biographical Notes on Authors and Collectors.* Sydney: Royal Zoological Society of New South Wales.

RIDE, W. D. L., 1970. — *A Guide to the Native Mammals of Australia.* Melbourne: Oxford University Press.

SMIT, F. G. A. M., 1957. — Siphonaptera. *Handbk Ident. Br. Insects* 1(16): 1-94.

——, 1958. — A preliminary note on the occurrence of *Pulex irritans* L. and *Pulex simulans* Baker in North America. *J. Parasit.* 44(5): 523-526.

——, 1979. — The fleas of New Zealand (Siphonaptera). *J. Roy. Soc. N.Z.* 9(2): 143-232.

——, 1982. — Siphonaptera. *In* PARKER, S. P. (ed.), *Synopsis and Classification of Living Organisms. Vol. 2:* 557-563. New York: McGraw-Hill.

——, 1983. — Key to the genera and subgenera of Ceratophyllidae. *In* TRAUB, R., ROTHSCHILD, M., and HADDOW, J. F. (eds), *The Rothschild Collection of Fleas. The Ceratophyllidae: Key to the Genera and Host Relationships:* 1-36. London: Rothschild and Traub.

——, 1987. — *An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History). VIII. Malacopsylloidea (Malacopsyllidae and Rhopalopsyllidae).* London: Trustees of the British Museum.

SMITH, K. G. V., 1987. — Darwin's insects. Charles Darwin's entomological notes. *Bull. Br. Mus. (Nat. Hist.) Histl ser.* 14(1): 1-143.

WALKER, E. P., WARNICK, F., HAMLET, S. E., LANGE, K. I., DAVIS, M. A., UIBLE, H. E., and WRIGHT, P. F., 1964. — *Mammals of the World. Vols 1, 2.* Baltimore: Johns Hopkins Press.